

of it are found in the Upper Silurian. The Silurian, Huronian, and Laurentian rocks are also found in Acadia, and have been elucidated by Dr. Honeyman, Mr. Hartt, and others. The economic geology of the region is kept well to the fore, also its physical geography and agricultural characteristics, as dependent on its geological structure. Many subjects of great interest in general geology are illustrated or described in this volume, especially the nature of coal, the flora of the coal, preservation of erect trees, origin of gypsum, life in seas, estuaries, &c., trails, rain-marks, and footprints, albertite, gold, primeval man, &c. Upwards of 270 woodcuts, mostly excellent in character, a good geological map, and, lastly, several lists of contents, special subjects, and illustrations, a valuable appendix, and useful index complete this satisfactory, well-written, and well-printed work on the geology and geological resources of Acadia. These large and varied provinces possess enthusiastic enlightened geologists, and furnish fields as rich for their research as the unprecedented supply of gold which Nova Scotia offers to the miner. It must be a mutual satisfaction to our Acadian brethren and ourselves to have at command this handsome and elaborate *résumé* of all that is known of the geology of that important region.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

June 11, 1868.—Lieut.-General Sabine, President, in the Chair.

“On the Osteology of the Solitaire or Didine Bird of the Island of Rodriguez, *Pezophaps solitaria* (Gmel.).” By ALFRED NEWTON, M.A., Professor of Zoology and Comparative Anatomy in the University of Cambridge, and EDWARD NEWTON, M.A., Auditor-General of Mauritius.

The Solitaire of Rodriguez was first satisfactorily shown to be distinct from the Dodo of Mauritius (*Didus ineptus*) by Strickland in 1844, from a renewed examination of the evidence respecting it, consisting of the account given by Leguat in 1708, and of the remains sent to France and Great Britain. Strickland, in 1848, further proved it to be generically distinct from the Dodo. The remains existing in Europe in 1852 were eighteen bones, of which five were at Paris, six at Glasgow, five in the possession of the Zoological Society (since transferred to the British Museum), and two in that of Strickland, who, at the date last mentioned, described them as belonging to *two* species, the second of which he named *Pezophaps minor*, from the great difference observable in the size of the specimens. In 1864 one of the authors visited Rodriguez, and there found in a cave two more bones, while a third was picked up by a gentleman with him. All these bones have been described, and most of them figured, in the publications of the Zoological Society, and in the large work of Strickland and Dr. Melville*.

* The Dodo and its Kindred. London: 1848, 4to.

Encouraged by his former success, that one of the authors of the present paper who had before been to Rodriguez urged Mr. George Jenner, the magistrate of the island, to make a more thorough search in its caves; and in 1865 this gentleman sent no less than *eighty-one* specimens to Mauritius. These were forthwith transmitted to London, and exhibited at a meeting of the Zoological Society in that year, when it appeared that the notion previously entertained of there having been two species of *Pezophaps* was erroneous, and that probably the difference in size of the specimens was sexual.

News of this last discovery reached England during the meeting of the British Association at Birmingham, and, prompted by Mr. P. L. Sclater, that body made a liberal grant to aid further researches. Owing to several causes, the scarcity of labourers in Rodriguez being the chief, nearly a year elapsed before these could be begun. But in 1866, some coolies having been expressly sent thither to dig in the caves, a very large collection of the bones of this bird, amounting to nearly *two thousand* specimens, was obtained. These specimens include almost all the most important parts of the skeleton, and furnish the authors with the material for the present paper.

This vast series of specimens shows that there was a very great amount of individual variability in the bird, so much so as to render the task of describing them minutely, and yet generally, a very difficult one. Yet, in consequence of this wealth of material, the authors have greater confidence in the opinions they declare. Professor Owen, having lately published a very detailed account of the osteology of the Dodo*, the present paper follows as closely as possible the mode of treatment he therein adopted, the authors thinking that they are so consulting the convenience of those who may wish to compare the structure of the two allied birds. Thanks to him, also, they have been able themselves to examine the very specimens which he described; and they are further indebted to many others—Mr. George Clark of Mauritius, Professors Reinhardt, Fritsch, and Alphonse Milne-Edwards, Sir William Jardine, and Mr. Flower, for valuable assistance in the shape of models or other additional material. To Mr. J. W. Clark they also mention their obligations for reconstructing from specimens in their possession the skeletons of the Dodo and of two Solitaires now exhibited.

The description of the latter follows in much detail, the amount of individual variability to which each bone was subject being specially dwelt on, and the whole compared bone by bone with that of the Dodo and also of *Didunculus*. *Pezophaps* differs from *Didunculus* quite as much as *Didus* does, but it is nearly allied to the latter. Still there are important differences. The neck was much longer than in *Didus*, and the vertebræ, on the whole, larger. The ribs also possess perhaps somewhat thicker heads and articular tubercles. The pelvis is much more rounded, and approaches that of

* "On the Osteology of the Dodo (*Didus ineptus*, Linn.)," Trans. Zool. Soc. vol. vi. pp. 49–85.

the normal Pigeons much more than that of *Didus* does; but in its posterior portion it differs very remarkably from that of any known bird; for the pubis in *Didus* has not yet been discovered. In the sternum *Pezophaps* generally agrees with *Didus*, but has some distinctive features. This bone shows articular surfaces for four sternal ribs only, instead of five, which seems to be the normal number in *Didus*; and the posterior extremity, so far as can be judged from the imperfect condition of the specimens, is very unlike what it is in that bird; but the characters deducible from this last portion in birds generally are shown to be very inconstant. The "scapular arch" differs from that of *Didus*, its constituent portions having been apparently never ankylosed as is the normal state there, and consequently resembling in this respect those of the generality of birds. The angle made by the junction of the coracoid and scapula cannot be accurately determined, but would appear to have been not much less than what it is in *Didus*. The scapula is of very peculiar form, unlike, so far as known to the authors, that of any bird, being inclined somewhat forward, and only pointing backward at its extremity, where it becomes spatulate in shape. The coracoid exhibits, as usual in this very significant bone, some good diagnostic characters. It is much stouter than it is in *Didus*—a fact not so surprising when the exceedingly abnormal form it there assumes is taken into consideration. At its sternal end it differs from that of most other birds, in the extension and rounding off of the outer border. Other peculiarities in it are also described, one of which appears to be sexual. This is the surface to which the scapula is articulated, and which in the large individuals (presumed to be males) is roughly quadrate, while in the smaller ones (the supposed females) it is triangular. In *Pezophaps* the bones of the wing are more massive and smoother than in *Didus*, judging from such remains of the latter as exist. The most remarkable thing about them, however, is the presence of a bony knob on the radial side of the metacarpal, unlike what is found in any other bird. It is large in some of the specimens, supposed to have belonged to old males, but very little developed in the presumed females. It is more or less spherical, pedunculate, and consists of a callus-like mass with a roughened surface, exceedingly like that of diseased bone, and was probably covered by a horny integument. It is situated immediately beyond the proximal end and the index, which last would appear to be thrust away by it to some extent. It answers most accurately and most unexpectedly to Leguat's description of it:—"L'os de l'aileron grossit à l'extrémité, et forme sous la plume une petite masse ronde comme une balle de mousquet." A description of its structure, as ascertained microscopically by Mr. J. Gedge, is added. The extremity of the wing is wanting. The leg-bones of *Pezophaps*, when compared with those of *Didus*, show more strongly developed ridges and muscular impressions, just the converse of what is observable in those of the wing; but the leg-bones having been minutely and correctly described by prior authors, it is unnecessary here to say much of them. Part of the skull, too, had been already described; but the only

specimen then known was so incrustated with stalagmite that not much could be made of it. The present remains show that it was very markedly different in many respects from that of *Didus*. The cranium is narrower and longer, and without the peculiar frontal protuberance of *Didus*, being nearly flat at the top, with the fore and hind part elevated into two bony ridges of cancellous structure. The upper mandible also presents a remarkable difference from that of *Didus*, where the axes of the nasal process and the maxillary converge, whereas in *Pezophaps* they diverge. The maxilla also was relatively very small; and the mandible differed by being much straighter above, showing a salient angle on its lower edge (which is very inconsiderable in *Didus*), and being much more solid posteriorly. In the quadrate the two birds are more alike. The rest of the bones of the head are wanting.

A comparison of the entire skeleton shows that *Pezophaps* is in some degree, and perhaps on the whole, intermediate between *Didus* and the normal *Columbæ*, while it has some features, such as the armature of the wing, quite peculiar. It has no very near affinity to *Didunculus*; indeed that form must be considered the type of a separate family, though not so aberrant as the *Dididæ*, which must be looked upon as the most remotely connected of the order *Columbæ*. Strickland was amply justified in arriving at the conclusion that the Solitaire of Rodriguez was generically distinct from the Dodo; but it seems expedient to define his genus *Pezophaps* more precisely. Accordingly the following characters are assigned to it:—

Rostrum mediocre, curvatum, processu nasali et ramis maxillaribus antice divergentibus. Frons plana, porcâ osseo-cancellatâ circumdata. Ossa coracoidea robusta. Alæ breves, involatiles. Manus singulis bullis osseo-calloso armatæ. Collum et pedes longiores.

In like manner the genus *Didus* may be defined:—

Rostrum magnum, aduncum, processu nasali et ramis maxillaribus antice convergentibus. Frons tumida, in umbonem hypoconicum osseo-cancellatum surgens. Ossa coracoidea attenuata, scapulas obtuse attingentia. Alæ breves, involatiles. Manus inermes. Collum et pedes breviores.

The account given by Leguat of his Solitaire is then quoted in full, as also that of d'Heguerty, the latter from Strickland, and the authors proceed to remark upon the different causes of extinction of species within historic time. This, when effected by man's agency, is seldom done by man's will; and various cases are cited to support this opinion. In extirpating species man generally acts indirectly; and they succumb to forces set in motion indeed by him, but without a thought on his part of their effect. In the case of the extinction of the Solitaire of Rodriguez, the cause usually suggested seems inadequate; and the authors consider it was probably effected by feral Swine, and quote a remarkable passage from an old French Voyage, showing the extraordinary abundance of these creatures in Mauritius, where, in or about the year 1708, above *fifteen hundred* had been slain in one day. It is plain that where these abounded

inactive birds could not long survive. It is supposed that the case was the same in Rodriguez as in Mauritius; for in every country newly discovered by Europeans, it has been an almost universal custom to liberate Pigs, and there is no reason to believe that the island first named was an exception thereto.

The extraordinary fidelity of Leguat's account of the Solitaire is next considered. It is borne out in every point save one, perhaps, by a study of the remains. The rugose surface at the base of the maxilla, the convexity of the pelvis, the somewhat lighter weight of the Solitaire than of the Dodo, its capacity for running, and, above all, the extraordinary knob on the wing, all agree with the description he has given us. The authors attempt also to account for the origin of this last by observing that its appearance is so exactly that of diseased bone, that it may have been first of all occasioned by injuries received by the birds in such combats with one another as Leguat mentions, and aggravated by the continuance of their pugnacity. The authors remark, also, that it is the habit of Pigeons to fight by buffeting with their pinions.

The particular in which Leguat may have erred is in the assertion, or perhaps rather inference, as to the monogamous habits of the Solitaire; and the cause of the error (if such it be) may be ascribed, without derogating from his truthfulness, to his anxiety to point a moral, which may have led him to imagine he saw what he wished to see. He especially mentions that one sex would not fight with the other, which is just what takes place among polygamous birds. The case of a very well-known bird (*Otis tarda*), about which much has been written, is then cited, to show that even now, after centuries of observation, it is doubtful whether it be monogamous or polygamous. Leguat, therefore, may easily have been mistaken in his opinion, even setting aside his evident leaning on the matter. The notion of *Pezophaps* having been polygamous was before entertained by one of the authors, and arises from a consideration of the great difference in the size of the two sexes, which in birds is generally accompanied by polygamous habits; but the question is now not likely to be solved.

The amount of variability which every bone of the skeleton of this species presents, warrants the conclusion that as much was displayed in those parts of its structure which have perished, letting alone Leguat's direct evidence as to the individual difference in the plumage of the females. If such a process, therefore, as has been termed "Natural Selection," or "Survival of the Fittest," exists, there would have been abundant room for it to operate; and there having been only one species of *Pezophaps* might, at first sight, seem an argument against the belief in such a process. A little reflection, however, will show that such an argument is unsound. Confined in a space so restricted as one small island, every individual of the species must have been subject to conditions essentially identical in all cases. Whatever power such a process might possess, there would be neither occasion nor opportunity for its operation, so long as no change took place in the physical character of the island.

But if we venture to indulge our fancy, and consider what would have been the inevitable result of a gradual upheaval of the island, and a corresponding extension of its area until it became vastly increased and its original low rounded hills were exalted into mountains, it is plain that a great variety of physical conditions would be thereby incurred. One side of the island would be exposed to the full force and direct influence of the trade-winds, the other side would be completely sheltered from them. The climate of these two portions would accordingly differ, and a great difference would be speedily wrought in the character of their vegetation, while that of the elevated central part would undergo a corresponding modification. After some longer or shorter period, we can conceive the island itself being broken up into two portions, separated from one another by a strait, such as divides the North and Middle Islands of New Zealand. This rupture would certainly tend still more to affect the existing fauna and flora; and at the end of another epoch there can be little doubt that the animals and plants of each portion, exposed to different influences, would present a decidedly different appearance, and the eastern and western islands (supposing the separation to have taken place in the direction of the meridian) might each possess its own special form of *Solitaire*, as the islands composing New Zealand have their peculiar species of *Apteryx*.

But it is only in such a case as has just been imagined that considerable modifications would be likely to be effected. It therefore seems to be no argument against the existence of such a process as that of "Natural Selection," to find a small oceanic island tenanted by a *single* species which was subject to great individual variability. Indeed a believer in this theory would be inclined to predicate that it would be just under such circumstances that the greatest amount of variability would be certain to occur. In its original state, attacked by no enemies, the increase of the species would only be dependent on the supply of food, which, one year with another, would not vary much, and the form would continue without any predisposing cause to change, and thus no advantage would be taken of the variability of structure presented by its individuals.

On the other hand, we may reflect on what certainly has taken place. Of the other terrestrial members of the avifauna of Rodriguez but few now remain. A small Finch and a Warbler, both endemic (the first belonging to a group almost entirely confined to Madagascar and its satellites, the second to a genus extending from Africa to Australia), are the only two land-birds of its original fauna now known to exist. The Guinea-fowl and Love-bird have in all probability been introduced from Madagascar; but the Parrots and Pigeons of which Leguat speaks have vanished. The remains of one of the first, and the description of the last, leave little room to doubt that they also were closely allied to the forms found in Madagascar and the other Mascarene islands; and thus it is certainly clear that *four* out of the *six* indigenous species had their natural allies in other species belonging to the same zoological province. It seems impossible on any other reasonable supposition than that of a common

ancestry to account for this fact. The authors are compelled to the belief that there was once a time when Rodriguez, Mauritius, Bourbon, Madagascar, and probably the Seychelles were connected by dry land, and that that time is sufficiently remote to have permitted the descendants of the original inhabitants of this now submerged continent to become modified into the many different representative forms which are now known. Whether this result can have been effected by the process of "Natural Selection" must remain an open question; but that the Solitaire of Rodriguez, and the Dodo of Mauritius, much as they eventually came to differ, sprang from one and the same parent stock, seems a deduction so obvious, that the authors can no more conceive any one fully acquainted with the facts of the case hesitating about its adoption than that he can doubt the existence of the Power by whom these species were thus formed.

MISCELLANEOUS.

Note on the Existence of a large Pelican in the Turbaries of England.

By A. MILNE-EDWARDS.

WE know very little about the birds of which the remains are found in turbaries, and hitherto their precise determination has never been attempted. There would nevertheless be much interest in such an examination, and in seeking what species of this class inhabited our countries at the period when the beaver, the urus, the aurochs, and the gigantic stag lived in great numbers in the forests and on the banks of the watercourses. I have recently been able to convince myself that investigations of this kind may furnish important results.

The turbaries of the neighbourhood of Cambridge have furnished a considerable number of the bones of birds, which Mr. Seeley and Prof. Alfred Newton have been kind enough to submit to my examination. I was astonished to find among these remains the bone of a pelican. This bone, which belongs to the Woodwardian Museum, was obtained from the turbaries of the marshy districts (fenlands) which cover the northern parts of the county of Cambridge. These deposits have been studied with much care by Mr. Seeley, who, with his usual obligingness, has furnished me with valuable information upon the subject.

Beneath peat in course of formation, of variable thickness, and containing some freshwater shells and existing plants, there is a clay filled with marine shells and containing some remains of marine mammalia. This clay rests upon a bed of peat in which the trunks of trees are met with, some of them still placed vertically. It is in this layer that the bones of terrestrial animals occur; and although the exact position where the humerus of the pelican was collected was not noticed, its colour and nature prove that it is derived from this peaty deposit. The mammalia indicated as occurring in it belong to the following species:—*Bos frontosus*, *B. primigenius*, *Cervus megaceros*, *Ursus arctos*, *Lutra vulgaris*, *Canis lupus*, *Cervus*